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Cropping systems, uses, and primary *in situ* characterization of Tanzanian pigeonpea (*Cajanus cajan* (L.) Millsp.) landraces

S.N. Silim[1], P.J. Bramel[2], H.B. Akonaay[3], J.K. Mligo[4] and J.L. Christiansen[5,*]
[1]*International Crops Research Institute for Semi-Arid Tropics (ICRISAT), P.O. Box 39063, Nairobi, Kenya;* [2]*International Crops Research Institute for Semi-Arid Tropics (ICRISAT), P.O. Box 776, Bulawao, Zimbabwe;* [3]*National Plant Genetic Resource Centre, Box 3024, Arusha, Tanzania;* [4]*Ilonga Agricultural Research and Training Institute, P O Ilonga, Kilosa, Tanzania;* [5]*Department of Agricultural Sciences, The Royal Veterinary and Agricultural University, 40 Thorvaldsensvej, 1871 Frederiksberg C, Copenhagen, Denmark; *Author for correspondence (e-mail: jlc@kvl.dk; fax: 3528 3460)*

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Abstract

Landraces of pigeonpea (*Cajanus cajan* (L.) Millsp.) were collected from farmer's fields in its major cropping areas in Tanzania. Passport data, including descriptors, information on cultural practices and uses were recorded. Pigeonpea intercropping with maize, sorghum and cassava were found to be the dominating cropping systems, with characteristic differences between regions. In the northern part of the country pigeonpea has been developed into a relatively high yielding cash crop. Also in part of the Coastal Zone and Eastern Plain a market, particularly for green pods, have been developed. It is also in these areas near Dar es Salam that pigeonpea is most frequently found as a garden crop.

The study showed that farmers mainly relay on self-saved seed, but seed is also quite often provided from other sources. About one third of the farmers selected sowing seed in the field at harvest. Seed storage was considered a great problem, and a variety of indigenous storage techniques were recorded. Chemical seed dressing was only common in the Northern Highlands, where the crop plays an important role as a cash crop. In all areas pigeonpea was consumed green as well as dry. Dry pigeonpea was most often consumed as whole grains, but dehulling was common especially in the Southern Plain. Most landraces identified were long-duration types, medium-duration types only being common in the Coastal Zone. The recorded plant and seed traits varied considerably, but the frequency of landraces with relatively large white or cream seeds and large pods was high in all regions. A number of accessions with potential resistance to fusarium wilt, bruchids and pod borer were identified.

Introduction

Pigeonpea (*Cajanus cajan* L. Millsp.) is an important grain legume in Eastern Africa. In Tanzania it ranks third among pulses after bean and cowpea in total production, and is the most important legume in many low-altitude areas, especially in Southern Tanzania. It is also widely grown in mid-altitude areas in the north (Mligo 1995).

Production systems in eastern and southern Africa are based on intercropping of unimproved long- and medium-duration landraces with cereals or various other long-duration crops (Singh 1991). A particular feature making pigeonpea interesting in local cropping systems is its slow canopy development that usually results in very high land equivalent ratio (LER) values when intercropped with cereals (Sivakumar and Virmani 1980). Its high protein content and superior ability to fix nitrogen (Katayama et al. 1996) are other valued characteristics. Even though pigeonpea is estimated to be grown on only about 66,000 ha in Tanzania (FAO 2002) the crop is considered relatively more important in its major cropping areas, and the area may be underestimated (Joshi et al. 2001).

The Indian Subcontinent is considered the centre of origin of pigeonpea, but a secondary centre of diversity is found in East Africa, where the crop has been grown for at least 4000 years (van der Maesen 1990). Most pigeonpea in Tanzania are landraces maintained by the farmers. Some breeding has been carried out in Tanzania as well as in a number of other African countries since the early 1960s. From the late 1980s breeding was accelerated when regional breeding of pigeonpea was initiated in collaboration with ICRISAT (Kimani 2001). Attempts to introduce new cultivars developed from Indian germplasm have, due to differences in agroecological conditions, generally not been very successful. The pronounced effect of photoperiod as well as temperature on flowering and canopy development in pigeonpea makes it necessary to tailor cultivars to specific climatic conditions (Silim and Omanga 2001). Short-duration types have mainly found a place in high input systems, but recently a number of promising medium and long-duration cultivars selected from local landraces developed by ICRISAT have been tested in Tanzania and other countries in the region with promising results (Silim 2001). In some areas such as Malawi, Kenya and northern Tanzania, the crop is becoming an important cash crop and considerable quantities are exported (Joshi et al. 2001).

East African pigeonpea germplasm is particularly known for large white or cream seeds and long pods (Remanandan 1990), and valuable resistance to pest and diseases has also been identified (Silim-Nahdy et al. 1999; Odeny 2001). Extensive collection of landraces has already taken place in Kenya (Kimani 2001) but no systematic collection of germplasm and information on farming systems and uses have been carried out in Tanzania. Increase in population is forcing farmers in eastern Africa to search for either high yielding or alternative crops with better productivity and returns. Move by farmers from growing pigeonpea to other non-N-fixing crops would result in a decline in soil fertility and environmental degradation. The likelihood of losing germplasm from the region and hence biodiversity is therefore high. The extent of genetic erosion is not known and the uniqueness of the material has not been determined.

This investigation included collection and primary *in situ* description of landraces of pigeonpea in the most important growing areas in Tanzania. The study included the gathering of information on cropping systems, seed systems, pest and disease problems and uses.

Materials and methods

We collected pigeonpeas during August–September 2001 in major pigeonpea growing areas in Tanzania. The collection sites were grouped into four major areas based on agro-ecological conditions: (1) Coastal Zone defined as areas up to 200 m a.s.l. along the coast comprising collection sites in Coastal, Dar es Salaam, and parts of Mtwara and Lindi Regions; (2) Eastern Plain, defined as areas above 200 m a.s.l. comprising all collection sites in Morogoro and Tanga Regions and a few sites in Coastal Zone; (3) Southern Plain, defined as areas above 200 m a.s.l. comprising most of the collection sites in Lindi and Mtwara Regions; (4) Northern Highlands which comprised collection sites in Arusha and Dodoma Regions, between 1200 and 1700 m a.s.l. The mission was planned to coincide with harvesting time of the crop in the respective areas. The strategy was to collect maximum diversity and at the same time collect superior landraces. Several criteria were considered while collecting: farmer was present in the field, the seed had been grown at least for one generation by the farmer, agronomic value of the landraces and targeting various cropping systems. Most collection sites were at least 1 km away from main roads and about 10 km apart.

In situ *characterization*

Landraces were identified and characterized in the field. Descriptors, modified from (IBPGR and

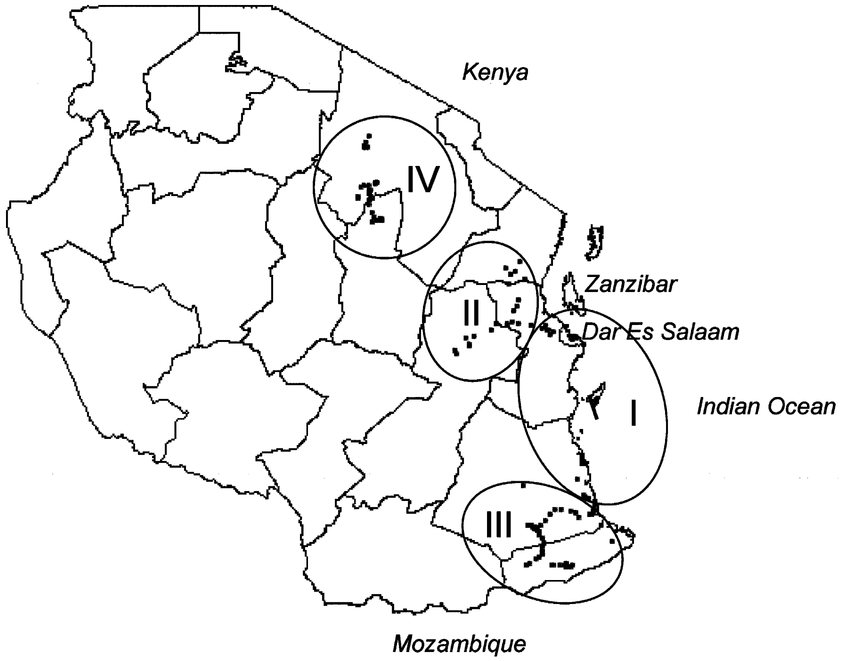

Figure 1. Map of Tanzania with collection sites for pigeonpea. (I) Costal Zone; (II) Eastern Plain; (III) Southern Plain; (IV) Northern Highlands.

ICRISAT 1993) included: maturity group based on days from sowing to maturity at the collection site (short-duration < 130 day, medium-duration > 130 day < 160 day and long-duration < 160 day), plant height, primary branching (low, medium, high); growth habit (compact, semi-spreading, spreading); base flower colour (yellow, ivory), dorsal side of flag (base colour, red, striped); pod length (short, medium, long); pod width (thin, medium, wide); seed colour (white, cream, brown, black, purple, speckled); hilum spot (absent, brown, red); seed size (small, medium, large), seed shape (globular, oval, elongated, square). Assessment of pest and diseases was based partly on farmers' information and partly on our own field assessment, and was made for fusarium wilt (*Fusarium udum*), pod borers (*Helicoverpa armigera*), pod suckers (*Clavigralla* sp.) and bruchids (*Callobruchus* spp.) in the field.

Structured interviews with farmers were carried out collecting information on local cropping systems, intercrops, second year management, harvesting and storage methods and utilization. Samples were later multiplied at Ilonga Experimental Station, Tanzania, and stored at ICRISAT, Hyderabad, India, and duplicates sent to Tanzania National Genetic Resource Centre, Arusha, Tanzania.

Results

A total of 126 accessions were sampled comprising 31 from Coastal Zone, 23 from Eastern Plain, 42 from Southern Plain and 30 from Northern Highlands (Figure 1). Collection was made at altitudes ranging from sea level to over 1600 m. Lowest elevations were recorded in the Coastal Zone (11–174 m), intermediate elevations in Eastern and Southern Plain (194–661 m and 168–785 m, respectively) and highest in the Northern Highlands (1199–1688 m).

Cropping system

A considerable variation in cropping systems was recorded, with characteristic differences between the zones (Table 1). Pigeonpea was most often sown with the onset of rain; however dry-sowing before the rain or late planting was also used in

Table 1. Cropping systems and management practices (in percent, number of responding farmers in brackets).

	Costal Zone ($N = 30$)	Eastern Plain ($N = 22$)	Southern Plain ($N = 41$)	Northern Highlands ($N = 30$)	Total ($N = 123$)	P
Sowing time						0.0031
Dry sowing	3.3 (1)	4.5 (1)	22 (9)	0	9 (11)	
Start of rains	83.3 (25)	81.8 (18)	73.2 (30)	100 (29)	83.6 (102)	
Late sowing (after beginning of rain)	13.3 (4)	13.6 (3)	4.9 (2)	0	7.4 (9)	
Cropping system						0.0012
Sole crop	3.6 (1)	0	2.4 (1)	0	1.7 (2)	
Intercropped	92.9 (26)	68.2 (15)	90.2 (37)	100 (29)	89.2 (107)	
Sole and intercrop	3.6 (1)	4.5 (1)	7.3 (3)	0	4.2 (5)	
Border	0	13.6 (3)	0	0	2.5 (3)	
Border and intercrop	0	13.6 (3)	0	0	2.5 (3)	
Intercrop system						<0.001
Garden	33.3 (9)	0	0	0	7.9 (9)	
Maize in same row	0	15.8 (3)	10.3 (4)	0	6.1 (7)	
Maize in same hole	18.5 (5)	0	7.7 (3)	0	7 (8)	
Maize in alternate ridges	0	0	15.4 (6)	89.7 (26)	28.1 (32)	
Cassava	3.7 (1)	10.5 (2)	0	0	2.6 (3)	
Maize, cassava	14.8 (4)	31.6 (6)	20.5 (8)	0	15.8 (18)	
Maize, cowpeas	3.7 (1)	0	0	3.4 (1)	1.8 (2)	
Maize, sorghum in alternate rows	0	10.5 (2)	7.7 (3)	3.4 (1)	5.3 (6)	
Maize, sorghum, cassava	22.2 (6)	5.3 (1)	30.8 (12)	0	16.7 (19)	
Maize, cassava, cowpeas	3.7 (1)	0	0	0	0.9 (1)	
Maize, sorghum, groundnuts	0	0	7.7 (3)	3.4 (1)	3.5 (4)	
Maize, sorghum, cowpeas	0	15.8 (3)	0	0	2.6 (3)	
Sorghum, cassava, cowpeas	0	5.3 (1)	0	0	0.9 (1)	
Maize, sorghum, cassava, cowpeas	0	5.3 (1)	0	0	0.9 (1)	
Second year management						<0.001
Ratoon crop	46.7 (14)	40.9 (5)	12.2 (5)	0	23 (28)	
Replant	23.3 (7)	22.7 (21)	51.2 (21)	100 (29)	50.8 (62)	
Both	30 (9)	36.4 (15)	36.6 (15)	0	26.2 (32)	
Second harvest						<0.001
Yes	100 (13)	0	91.7 (11)	3.4 (1)	46.3 (25)	
No	0	0	8.3 (1)	96.6 (28)	53.7 (29)	

N = Number of farmers visited. P for Fisher's exact test.

all zones except in the Northern Highlands. Intercropped pigeonpea was the most common in all areas, accounting for 90% of all fields, but sole cropping, and planting in field borders were also practiced. Different intercrops dominated in different regions. The most common intercrops were maize and cassava in the Coastal Zone and Eastern Plains; maize, sorghum, and cassava in the Southern Plain and maize in the Northern Highlands. In the highlands, mainly alternate rows of maize and pigeonpea were planted, each component at its sole-crop population density, leading to very high productivity. This system also provides large quantities of pigeonpea stems that are used as fuel wood. In the Coastal Zone and Eastern Plains pigeonpea was frequently ratooned. This practice was not used in the productive system in the Northern Highlands. In the Coastal Zone one third of the farms visited had pigeonpea as a garden crop near the homestead.

Seed system

Most farmers used self sawed seed, and only about 14% had obtained seed from other sources. In one case seed was gathered from an upturned truck in a road accident, and turned out to be a useful variety for the area (Table 2). Methods of seed selection for sowing varied between zones. In the Eastern, Coastal Zone and Southern Plain healthy pods were frequently selected at harvest and stored for use as seed. This practice may help maintain the

Table 2. Seed systems and seed storage methods (in percent of farmers, number of responding farmers in brackets).

	Costal Zone ($N = 30$)	Eastern Plain ($N = 22$)	Southern Plain ($N = 41$)	Northern Highlands ($N = 30$)	Total ($N = 123$)	*P*
Source of seed						0.041
Own	73.3 (22)	81.8 (18)	87.8 (36)	89.7 (26)	83.6 (102)	
Purchase in market	3.3 (1)	13.6 (3)	7.3 (3)	6.9 (2)	7.4 (9)	
Received from others	23.3 (7)	0.0	4.9 (2)	3.4 (1)	8.2 (10)	
Road accident	0.0	4.5 (1)	0.0	0.0	0.8 (1)	
Seed storage						<0.001
In pods	69.0 (20)	63.6 (14)	78.0 (32)	0.0	54.5 (66)	
Threshed seed	31.0 (9)	36.4 (8)	22.0 (9)	100.0 (29)	45.5 (55)	
Seed conservation						<0.001
Seed with insecticide	3.6 (1)	11.1 (2)	10.0 (4)	62.1 (18)	21.7 (25)	
Seed with paraffin	0.0	0.0	0.0	0.0	1.7 (2)	
Seed with sand or ash	25.0 (7)	5.6 (1)	0.0	0.0	7.0 (8)	
Seed without treatment	17.9 (5)	27.8 (5)	2.5 (1)	24.1 (7)	15.7 (18)	
Pods in kitchen	25.0 (7)	0.0	0.0	0.0	6.1 (7)	
Pods in bag in house	21.4 (6)	33.3 (6)	15.0 (6)	0.0	15.7 (18)	
Food/seed in traditional basket	0.0	0.0	52.5 (21)	0.0	18.3 (21)	
Branch in kitchen	3.6 (1)	22.2 (4)	10.0 (4)	0.0	7.8 (9)	
Pods in traditional seed store	3.6 (1)	0.0	0.0	10.3 (3)	3.5 (4)	
Pods in grass in trees	0.0	0.0	5.0 (2)	3.4 (1)	2.6 (3)	
Seed selection						<0.001
Healthy seed at planting	10.7 (3)	27.3 (6)	51.2 (21)	3.4 (1)	25.8 (31)	
Healthy pods at harvest	50.0 (14)	54.5 (12)	34.1 (14)	0.0	33.3 (40)	
Healthy plants at harvest	0.0	9.1 (2)	0.0	0.0	1.7 (2)	
None	39.3 (11)	9.1 (2)	14.6 (6)	96.6 (28)	39.2 (47)	

N = Number of farmers visited. *P* for Fisher's exact test.

genetic purity, but it also reduces risk of bruchid infestation. In the Northern Highlands, where pigeonpea is a cash crop, seed was not separated from grain and at sowing grain not sold or consumed was cleaned and used for sowing. In Dodoma which is part of Northern Highlands, farmers often maintained two traditional cultivars, one for eating and one for selling. Seed was stored shelled or unshelled in the pod. In the Coastal Zone and Eastern and Southern Plain about two-thirds of farmers stored seeds unshelled. Storage in pods is believed to help control bruchid damage, a major problem in the south. In the Northern Highlands all farmers stored shelled seed.

Farmers used a variety of control methods against storage pests. Only 16% of the farmers did not use any seed treatment. Chemical seed dressing was used by 62% of the farmers in the Northern Highlands. In the other regions use of chemicals was low, varying from 4% to 10%. The prevalent chemical in use was Actelic (pirimiphos-methyl).

Pests and diseases

The major pests reported by farmers were pod borers, pod suckers and bruchids (Table 3). Pod borers which are field pests were present in all regions, with the highest level in the Eastern and Southern Plains. Some varieties in the Southern Plain appeared to have some resistance. Incidents of pod suckers, another field pest, were highest in the Coastal Zone and Eastern Plains. A number of accessions collected in the Eastern Plain and the Northern Highlands appeared to be resistant. Bruchids in some instances start infestation in the field, but most damage occurs in storage (Silim-Nahdy et al. 1999). We observed high levels of field infestation of bruchids in the Southern Plains and there appeared to be a level of resistance in some lines in the Eastern Plains, and some apparently resistant lines were identified in the Southern Plain.

Fusarium wilt was prevalent in all regions. Even in the Northern Highlands where the incidence

Table 3. Pest and diseases problems reported (in percent of farmers, number of responding farmers in brackets).

	Costal Zone ($N = 30$)	Eastern Plain ($N = 22$)	Southern Plain ($N = 41$)	Northern Highlands ($N = 30$)	Total ($N = 123$)	P
Fusarium						<0.001
Absence	24.1 (7)	22.7 (5)	17.1 (7)	51.7 (34)	28.1 (34)	
Low	6.9 (2)	13.6 (3)	2.4 (1)	27.6 (14)	11.6 (14)	
Average	69.0 (20)	45.5 (10)	68.3 (28)	3.4 (59)	48.8 (59)	
High	0.0	18.2 (4)	12.2 (5)	17.2 (14)	11.6 (14)	
Pod borers (*Helicoverpa armigera*)						<0.001
Present	65.5 (19)	86.4 (19)	87.8 (36)	62.1 (18)	76.0 (92)	
Absent	34.5 (10)	0.0	12.2 (5)	37.9 (11)	21.5 (26)	
Resistant lines identified	0.0	13.6 (3)	0.0	0.0	2.5 (3)	
Pod suckers (*Clavigralla* sp.)						<0.001
Present	60.0 (18)	63.6 (14)	12.2 (5)	27.6 (8)	36.9 (45)	
Absent	40.0 (12)	27.3 (6)	87.8 (36)	69.0 (20)	60.7 (74)	
Resistant lines identified	0.0	9.1 (2)	0.0	3.4 (1)	2.5 (3)	
Bruchids (*Callobruchus* spp.)						<0.001
Present	17.2 (5)	0.0	19.0 (4)	15.4 (2)	12.9 (11)	
Absent	75.9 (22)	100.0 (22)	28.6 (6)	84.6 (11)	71.8 (61)	
High levels	6.9 (2)	0.0	42.9 (9)	0.0	12.9 (11)	
Resistant lines identified	0.0	0.0	9.5 (2)	0.0	2.4 (2)	

N = Number of farmers visited. P for Fisher's exact test.

Table 4. Uses and cooking time in comparison to *Phaseolus* beans (in percent of farmers, number of responding farmers in brackets).

	Costal Zone ($N = 30$)	Eastern Plain ($N = 22$)	Southern Plain ($N = 41$)	Northern Highlands ($N = 30$)	Total ($N = 123$)	P
End use						<0.001
Green only	10.3 (3)	9.1 (2)	2.4 (1)	3.4 (1)	5.8 (7)	
Green and whole	48.3 (14)	86.4 (19)	4.9 (2)	96.6 (28)	52.1 (63)	
Green whole split with round grinding stone	34.5 (10)	0.0	14.6 (6)	0.0	13.2 (16)	
Green whole split with elongate grinding stone	3.4 (1)	0.0	58.5 (24)	0.0	20.7 (25)	
Green whole split with either stone	3.4 (1)	4.5 (1)	19.5 (8)	0.0	8.3 (10)	
Cooking time						<0.001
Longer than for common beans	58.3 (14)	5.0 (1)	17.1 (7)	44.8 (13)	30.7 (35)	
Similar to common beans	4.2 (1)	20.0 (4)	0.0	17.2 (5)	8.8 (10)	
Faster than common beans	37.5 (9)	75.0 (15)	82.9 (34)	37.9 (11)	60.5 (69)	

N = Number of farmers visited. P for Fisher's exact test.

appeared low the disease is severe in concentrated pockets of high incidence. Insufficient crop rotation seems to be a major cause of fusarium wilt. Some landraces collected appeared resistant to fusarium wilt.

Utilization

Pigeonpea in Tanzania is used in three ways: as green peas, whole dry grains, or split into dhal (Table 4). In the Northern Highlands, the crop is considered a cash crop and a large proportion of the production is sold. In some areas in the Eastern Plain it appears that production is kept low because of lack of stable market access. A market exists for green pigeonpea in Zanzibar and Dar Es Salaam. Dehulling was used in all areas except in the Northern Highlands, and was especially frequent in the Southern Plain where pigeonpea is the most important grain legume. There were quite conflicting views on cooking time as compared to beans. However a majority of respondents reported that pigeonpea cooked faster than beans.

Primary characterization of germplasm

Most of the accessions were classified as long-duration types, and medium-duration types were found only in the Coastal Zone (Table 5). In the Coastal Zone and the Eastern Plains most plants were tall to very tall, while in the Southern Plain about half were characterized as tall and the rest divided between medium and very tall. In the Northern Highlands plants were mostly medium tall or tall. Growth habit and number of primary branches varied considerably, but these characters depend to a large extent on plant population.

Various flower colours were observed, and often variation was found in the same field. Yellow base colour was more common than ivory, and about one quarter was red or had red stripes on the dorsal side of the flag (Table 5). Pod colour was most frequently green or striped, with a lower proportion of entirely purple pods (Table 5). Also this character was often observed to vary within the field. Pods were generally medium to long, a few accessions having very long pods, sometimes with up to nine seeds per pod. Pod width varied from thin to wide, with fairly equal proportions in each group. A great variation in seed colour was observed often with some variation within an accession, however, a large proportion of seeds were cream and white in colour. About half of the accession in the Coastal Zone and the Eastern and Southern Plains were cream and about three quarters of the lines in the Northern Highlands were white or cream. The proportion of small seeded accessions was low in all regions, highest in Northern Highlands with more than 20% small seeded lines. About 25% of all accessions had large seed. Most seeds were oval or globular in the Northern Highlands, and over 90% of the accessions had globular seed.

Discussion

Farmers in Tanzania still mainly grow their own landraces and there is no sign of genetic erosion of the pigeonpea germplasm. However medium- and long-duration cultivars developed by ICRISAT are now being introduced by the national research system. Some of these selections are rapidly adopted in Kenya (Jones et al. 2001; Kimani 2001). Especially in areas as the Northern Highlands, where the pigeonpea plays an important role as a cash crop, local germplasm may rapidly be lost as bold seeded, higher yielding and wilt resistant selections are being introduced. The earlier collections of germplasm in East Africa have already proved valuable. Thus a number of recent ICRISAT lines under introduction, based on local germplasm, or crosses between local landraces and improved Indian cultivars have proved superior to cultivars developed in India (Silim 2001). Particular traits of interest in the East African germplasm are large, white or cream coloured seeds and large pods (Kimani et al. 2001), which were also frequently found in our study. The sensitivity to day length and temperature found in pigeonpea (Ellis et al. 1998; Silim and Omanga 2001) makes it important to collect genetic sources from various agro-ecological zones, but it also complicates germplasm assessment. It should be noted that crop development in pigeonpea is very dependent on day length and temperature and thus characters such as days to flower and maturity, plant height and canopy development may divers greatly if grown under conditions different from those prevailing at the site of collection or area of adaptation.

Pests are regarded as a major constraint to pigeonpea production (Hillocks et al. 2000). In eastern Africa reports indicate that losses in farmers fields during two seasons in four countries were 14–22% (Minja et al. 1999), and storage losses can also be considerable (Silim-Nahdy and Agona 2001). Important losses due to fusarium wilt have been reported. Various sources for resistance are available from East African germplasm, and several races of the pathogen exist (Odeny 2001), underlining the importance of new sources. Potential resistant accessions in the collection will have to be further tested in sick plots. The importance of pests and diseases is confirmed in our study by the awareness of the farmers. Wilt, as well as major pests as pod borers, pod suckers and bruchids were well-known problems in most fields. A particular problem seems to be seed

Table 5. In situ primary characterization (in percent of accessions, number of accessions in brackets).

	Costal Zone ($N = 30$)	Eastern Plain ($N = 22$)	Southern Plain ($N = 41$)	Northern Highlands ($N = 30$)	Total ($N = 123$)	P
Maturity group						<0.001
Medium duration	20.6 (7)	0.0	0.0	0.0	6.5 (7)	
Long duration	79.4 (27)	100.0 (16)	100.0 (29)	100.0 (29)	93.5 (101)	
Plant height						<0.001
Medium	6.9 (2)	5.6 (1)	27.0 (10)	46.9 (15)	24.1 (28)	
Tall	44.8 (13)	27.8 (5)	51.4 (19)	43.8 (14)	44.0 (51)	
Very tall	48.3 (14)	66.7 (12)	21.6 (8)	9.4 (3)	31.9 (37)	
Primary branching						ns
Low	35.7 (10)	16.7 (3)	25.7 (9)	18.2 (6)	24.6 (28)	
Medium	50.0 (14)	61.1 (11)	65.7 (23)	63.6 (21)	60.5 (69)	
High	14.3 (4)	22.2 (4)	8.6 (3)	18.2 (6)	14.9 (17)	
Growth habit						0.013
Compact	33.3 (10)	50.0 (9)	21.6 (8)	6.9 (2)	25.4 (29)	
Semi-spreading	56.7 (17)	50.0 (9)	73.0 (27)	89.7 (26)	69.3 (79)	
Spread	10.0 (3)	0.0	5.4 (2)	3.4 (1)	5.3 (6)	
Flower colour						ns
Ivory	19.4 (6)	31.8 (7)	20.0 (10)	18.2 (6)	21.3 (29)	
Yellow	54.8 (17)	45.5 (10)	58.0 (29)	57.6 (19)	55.1 (75)	
Red	25.8 (8)	22.7 (5)	22.0 (11)	24.2 (8)	23.5 (32)	
Pod colour						ns
Green	55.8 (24)	48.6 (17)	51.6 (32)	41.4 (24)	49.0 (97)	
Purple	0.0	8.6 (3)	11.3 (7)	12.1 (7)	8.6 (17)	
Striped	44.2 (19)	42.9 (15)	37.1 (23)	46.6 (27)	42.4 (84)	
Pod length						<0.001
Short	5.9 (2)	0.0	9.8 (5)	3.3 (1)	5.6 (8)	
Medium	20.6 (7)	37.0 (10)	35.3 (18)	93.3 (28)	44.4 (63)	
Long	67.6 (23)	59.3 (16)	49.0 (25)	3.3 (1)	45.8 (65)	
Very long	5.9 (2)	3.7 (1)	5.9 (3)	0.0	4.2 (6)	
Pod width						ns
Narrow	18.2 (6)	22.2 (6)	30.4 (17)	17.1 (6)	23.2 (35)	
Medium	51.5 (17)	40.7 (11)	35.7 (20)	65.7 (23)	47.0 (71)	
Wide	30.3 (10)	37.0 (10)	33.9 (19)	17.1 (6)	29.8 (45)	
Seed colour						<0.001
White	0.0	0.0	1.5 (1)	50.0 (23)	11.6 (24)	
Cream	51.0 (25)	50.0 (22)	55.9 (38)	23.9 (11)	46.4 (96)	
Cream with brown spots	18.4 (9)	15.9 (7)	11.8 (8)	6.5 (3)	13.0 (27)	
Cream with red spots	0.0	4.5 (2)	1.5 (1)	0.0	1.4 (3)	
Speckled	2.0 (1)	15.9 (7)	19.1 (13)	13.0 (6)	13.0 (27)	
Brown	28.6 (14)	4.5 (2)	10.3 (7)	6.5 (3)	12.6 (26)	
Black	0.0	4.5 (2)	0.0	0.0	1.0 (2)	
Purple	0.0	4.5 (2)	0.0	0.0	1.0 (2)	
Seed size						ns
Small	9.7 (3)	6.5 (2)	10.9 (6)	23.8 (10)	13.2 (21)	
Medium	77.4 (24)	54.8 (17)	60.0 (33)	54.8 (23)	61.0 (97)	
Large	12.9 (4)	38.7 (12)	29.1 (16)	21.4 (9)	25.8 (41)	
Seed shape						<0.001
Elongate	10.5 (4)	31.3 (10)	18.3 (13)	0.0	15.6 (27)	
Oval	47.4 (18)	40.6 (13)	43.7 (31)	9.4 (3)	37.6 (65)	
Globular	42.1 (16)	25.0 (8)	36.6 (26)	90.6 (29)	45.7 (79)	
Square	0.0	3.1 (1)	1.4 (1)	0.0	1.2 (2)	

N = Number of accessions collected. Note that more than one distinct type was recorded in some accessions. P for Fisher's exact test, ns = non-significant at the 0.05 level.

storage, where a variety of indigenous techniques were recorded. Accessions have been identified, with hairy pods reported as efficient to reduce egg laying by bruchids on mature pods (Silim-Nahdy et al. 1999). Sources of resistance to fusarium wilt and pests will be used in our breeding efforts. Similarly different techniques used by framers for pest control will also be evaluated for their efficacy.

Our study confirm that pigeonpea in Tanzania is commonly consumed green as well as dry. Singh (1995) reports that consumption of whole boiled seed is the major form in Africa, however our study indicate that dehulling is quite common especially in the Southern Plain, where pigeonpea is the most important food legume. The dehulling process will reduce cooking time and improve starch digestibility (Duhan et al. 1998), but may also cause important losses of protein, calcium and iron (Singh 1995). However in the area visited it was observed that care is taken not to loose valuable remains from the dehulling process. The variation in assessment of cooking time in comparison to phaseolus beans can partly be explained by variation in genotypes (Singh 1995), and may be an important selection criterion.

Pigeonpea looks more important than the 66,000 ha estimated by the official statistics (FAO 2002). A more precise assessment of the importance of the crop is therefore recommended in order to develop further strategies for pigeonpea research in Tanzania.

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